



Superconducting Magnet Program

Magnet design and Technologies

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BERKELEY LAB

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Superconducting Magnet Program



Fabrication Enhancements

Topics

- Horseshoe Frame construction
- Potting Tooling Improvements
- High Pressure Bladder Redesign



Subscale Horseshoe and Coil Parts

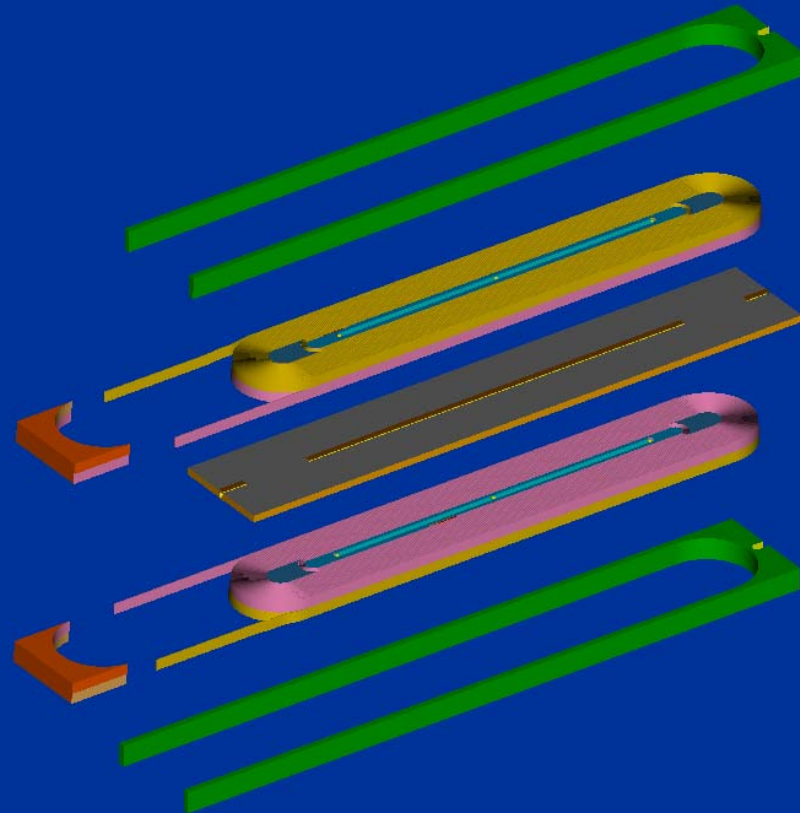
- The horseshoe coil support frame was incorporated as a cost savings idea.
- It has proven to be effective in reducing the number of coil parts and as a better way of supporting the coil during reaction, epoxy potting and assembly of the magnet.



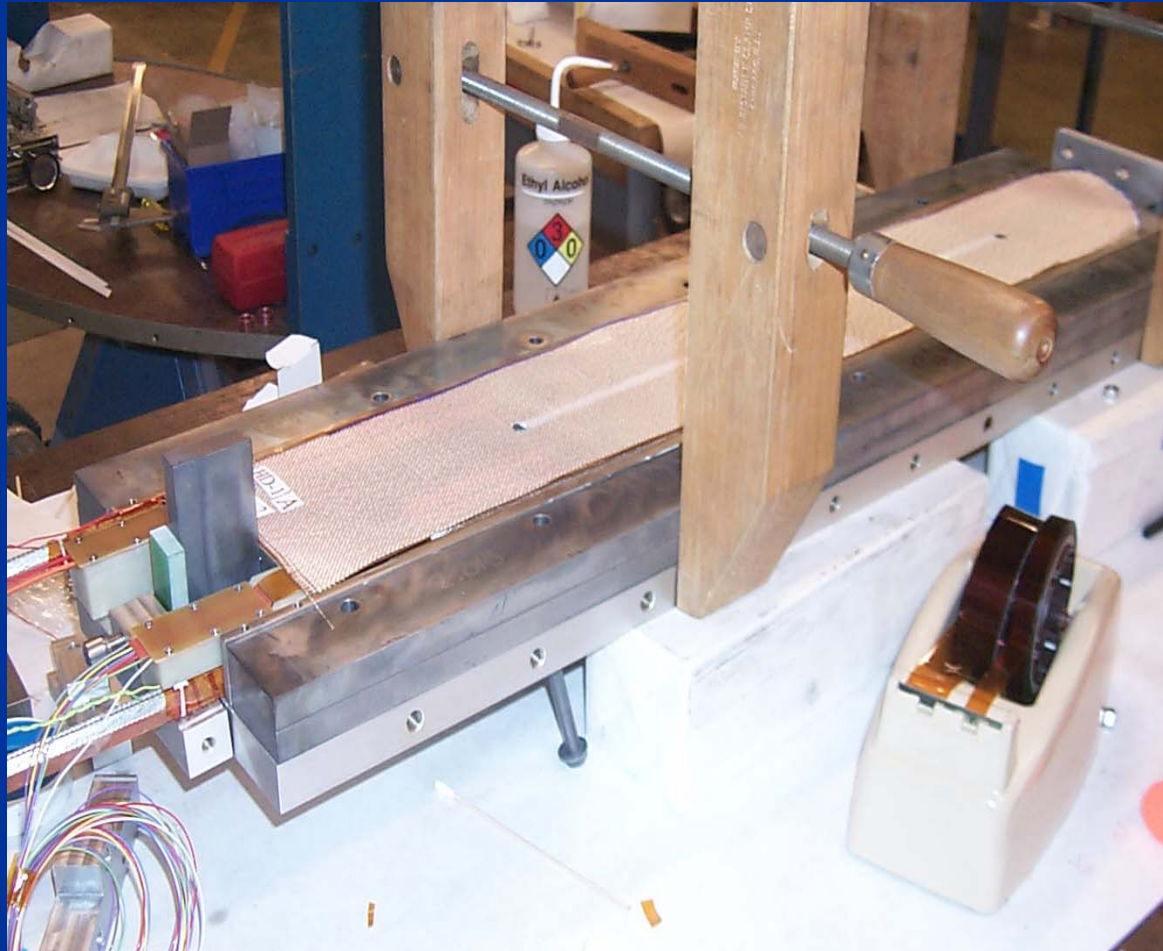


HD-1 Horseshoe

- The horseshoe coil support has been incorporated into the Large Magnet HD-1.
- The material in the HD-1 horseshoe will be optimized to improve the coil loading during cool down.



Potting Tooling Improvements





Potting Tooling Improvements

- The epoxy reservoir stays at room temp allowing backfilling of the epoxy during curing.

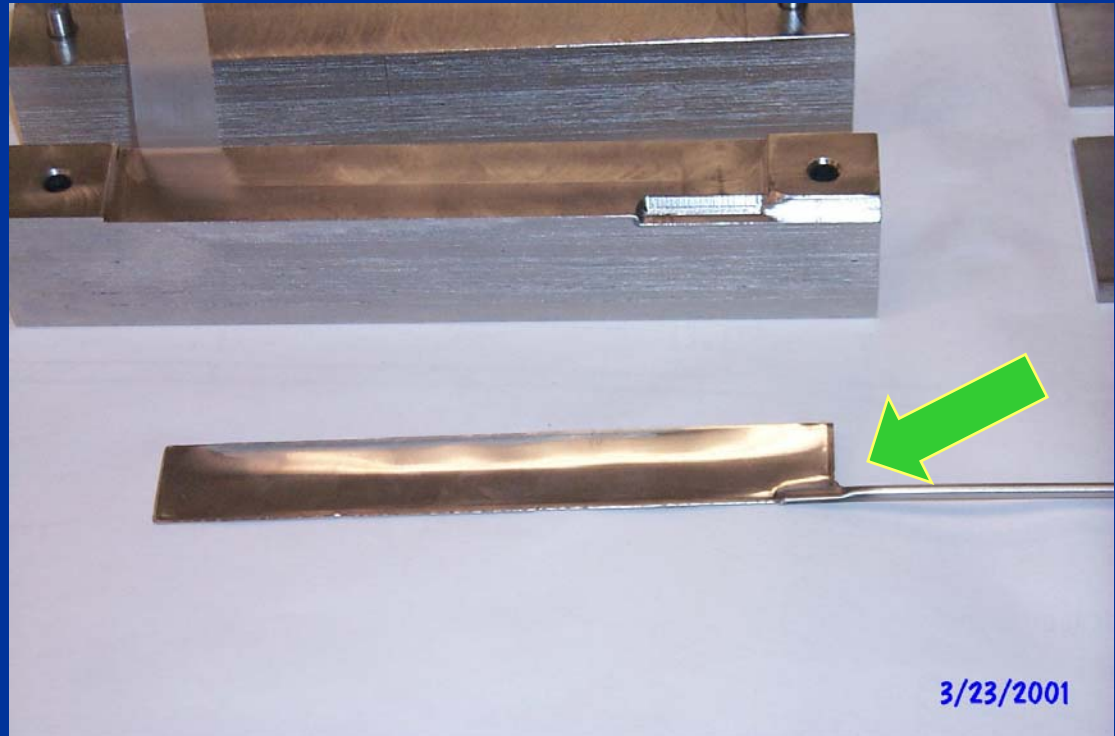


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High Pressure Bladders

- The original design worked well but was limited by the tube weld on the corner of the bladder.
- The tube weld proved to be the point of failure for the majority of all bladders tested.
- In order to make this system more reliable we needed a better way to connect the heavy wall tube.



High Pressure Bladders

- A block design was built and tested.
- This design allows the manufacturer to laser weld the block to the top sheet of the bladder.
- After the block is attached, the top and bottom sheets can be laser welded together without the tube obstructing the machine path.





High Pressure Bladders

- After the laser welding is complete the tube can easily be TIG welded by hand.
- This new process has shown an increase in reliability and performance.
- Original requirements; hold 10,000 PSI @ 3MM expansion.
- New performance; holds 10,000 + PSI @ over 4 MM expansion.





Improved Documentation

This effort has lead to improved procedures for all aspects of coil and magnet development.

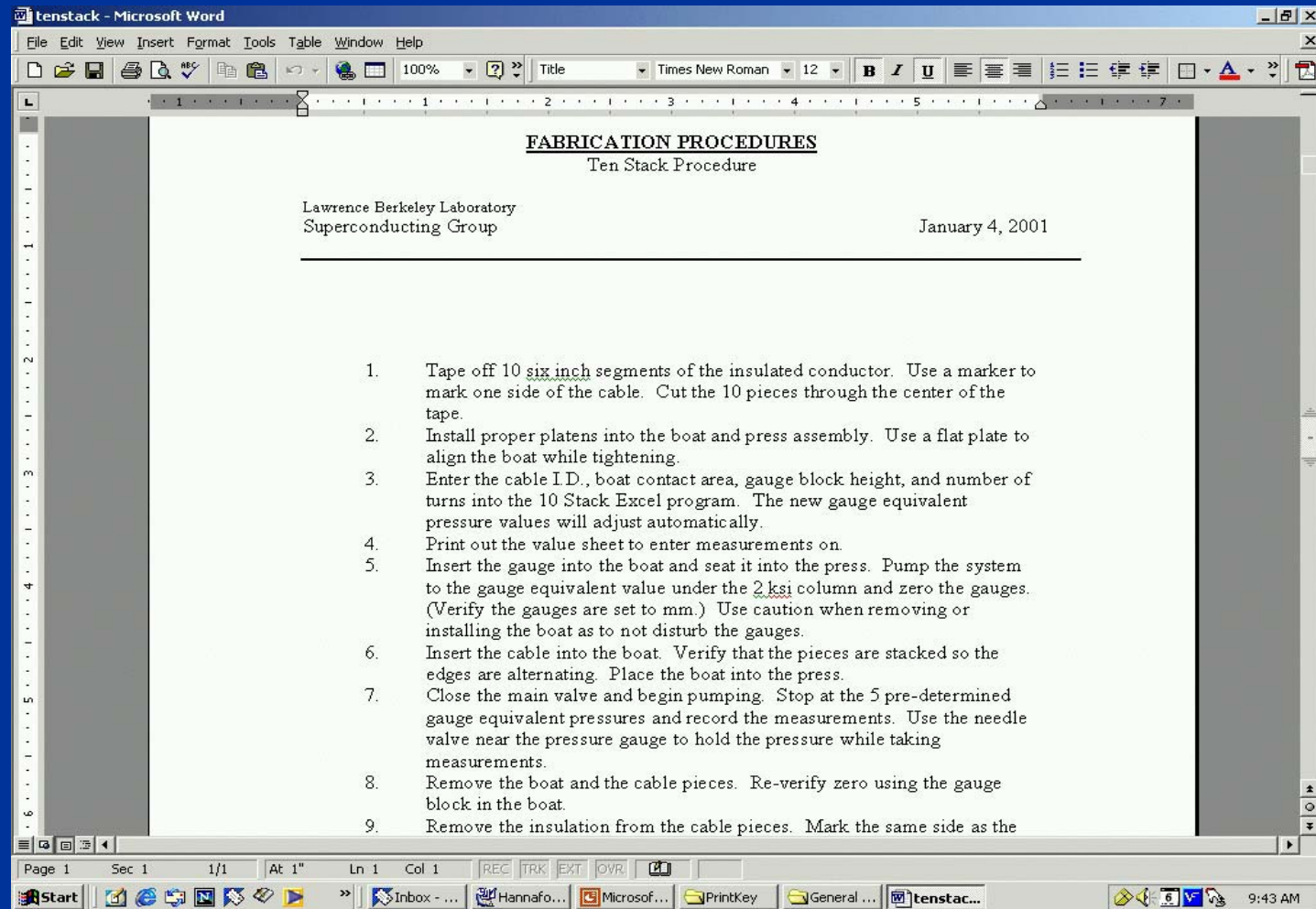
- 25 Written Procedures.
- 30 Data spread sheets.
- Hundreds of Digital Photos.
- All data available on line.



Improved Documentation

One of many
typical
procedures
available:

Conductor
Ten Stack
Measurement



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Improved Documentation

Conductor Ten Stack Data Sheet

Enter
information in
the yellow
boxes and
Excel
computes:

- Cable Size
- Insulation Thickness
- Coil Size

Microsoft Excel - 10Stackformula

File Edit View Insert Format Tools Data Window Help

N25

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Cable Type											Date:				
2																
3												Perpetrators:				
4	Piston Area (mm ²) =	1385														
5					Boat Base Width											
6	Boat Contact Area (mm ²) =	0.00														
7					Boat Base Length											
8	Gauge Block Height (h)															
9																
10	Pressure (ksi)	1			2			3			4			5		
11	Gauge Equivalent Pressure (Psi)	0			0			0			0			0		
12		A	B	Avg	A	B	Avg	A	B	Avg	A	B	Avg	A	B	Avg
13	Bare Cable Stack			0			0			0			0			0
14	Insulated Cable Stack			0			0			0			0			0
15																
16	Bare Cable Thickness (mm)			0.000			0.000			0.000			0.000			0.000
17	Insulated Cable Thickness (mm)			0.000			0.000			0.000			0.000			0.000
18	Insulation Thickness (mm)			0.000			0.000			0.000			0.000			0.000
19	Coil Size (mm)			0.000			0.000			0.000			0.000			0.000
20	Number of Turns															
21	All measurements are in metric. Fill in all the yellow shaded cells.															
22																
23																
24		Summary														
25		ksi	Bare	Insulated	Insulation	Coil Size										
26		1	0	0.000	0.0000	0.000										
27		2	0	0.000	0.0000	0.000										
28		3	0	0.000	0.0000	0.000										
29		4	0	0.000	0.0000	0.000										
30		5	0	0.000	0.0000	0.000										

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Improved Documentation

Coil Sizing Data Sheet

Enter information in the yellow boxes and Excel computes:

- Total coil size
- Shim size needed to load coil to 2000 PSI

Microsoft Excel - Coil Size					
File Edit View Insert Format Tools Data Window Help					
J5 =					
	A	B	C	D	E
2	Coil Sizing Chart				
3					
4	Coil Number				
5	Date:				
6	Taken By:				
7	Coil Package Components	Nominal	Number of	Total	Actual
8		Size (mm)	Components		mm
9			Turns		
10	Insulated conductor @ 2 ksi equivalent			0	0
11	Mica Paper (Island only)		2	0	0
12	Island/Plasma Spray		1	0	0
13	Horseshoe Width		2	0	0
14					
15	Total (Lines 10 - 13)	0			0.00
16					
17	Reaction Rail Width		2	0	0
18					
19	Coil With Horseshoe (15 + 17)				0.00
20					
21					
22	Plate		1	0	0
23	Glass Overhang		2	0	0
24					
25	Effective Plate Size (22 + 23)				0.00
26					
27	Difference (19 - 25)				0.00
28	Positive Number means larger coil				
29					
30	Shim Size mm / per side	0.00	+	Line 27/2	0
31	Shim Size in inches / per side				0.000
32	Shim Size is .054" Maximum! If bigger, try another turn.				
33					
34	Fill in yellow boxes for proper calculations.				
35					



Improved Documentation

“Large Coil”

Pre Reaction Coil Sizing Data Sheet

- This information is recorded and checked after Reaction to compare conductor movement.

Microsoft Excel - Pre Coil Dimensions

File Edit View Insert Format Tools Data Window Help

J21 =

	A	B	C	D	E	F
1	Pre-Reaction Coil Dimensions					
2	DATE:			COIL #		
3						
4	TAKEN BY:			LAYER:		
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20	After the top plate and side rails			Before the coil is covered, take the		
21	are installed, measure the outside			following dimensions:		
22	dimensions of the coil package.					
23						
24	A			H		
25	B			I		
26	C			J to 1st spacer		
27	D			J total		
28	E			K		
29	F			L		
30	G			ISLAND GAP		



Summary of Fabrication Enhancements

All the fabrication improvements this past year were tested using the sub scale program as a test bed.

The benefits of these improvements are:

- Cost savings due to less tooling.
- Rapid turn around of new ideas.
- Time savings due to reliable procedures.
- Information readily available on line.